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Koshiyama et al.

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(54) **FORCE-DISTRIBUTING APPARATUS FOR A BICYCLE WHEEL SPOKE**

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B60B 1/04 (2006.01)
B60B 27/02 (2006.01)

(52) **U.S. Cl.**
CPC ***B60B 1/04*** (2013.01); ***B60B 1/042*** (2013.01); ***B60B 27/023*** (2013.01)

(58) **Field of Classification Search**
CPC B60B 1/04; B60B 1/041; B60B 1/042; B60B 1/044; B60B 1/045
USPC 301/55, 56, 59, 61, 104
See application file for complete search history.

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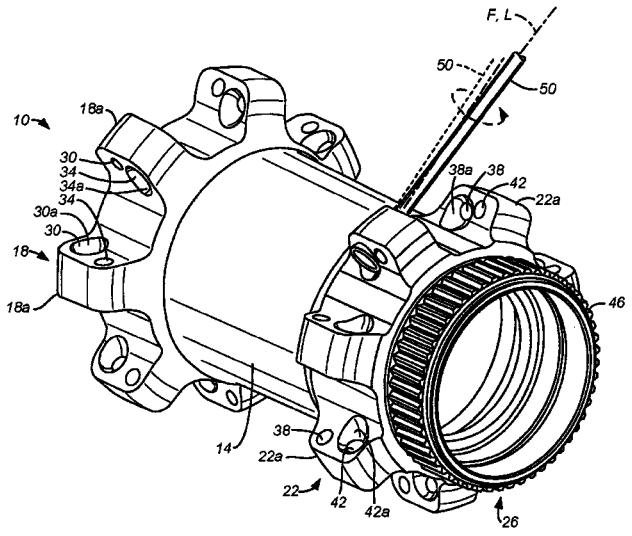
(57) **ABSTRACT**

A force-distributing apparatus for a bicycle wheel spoke includes a force-distributing body having a free-end first surface and a second surface disposed at an opposite side of the first surface. The force-distributing body has a spoke-receiving opening that extends through the first surface. In one embodiment, the first surface substantially has the shape of a truncated sphere. In another embodiment, the force distributing body has a generally cylindrical shape. In another embodiment, the spoke-receiving opening is formed eccentrically in the force-distributing body.

15 Claims, 11 Drawing Sheets



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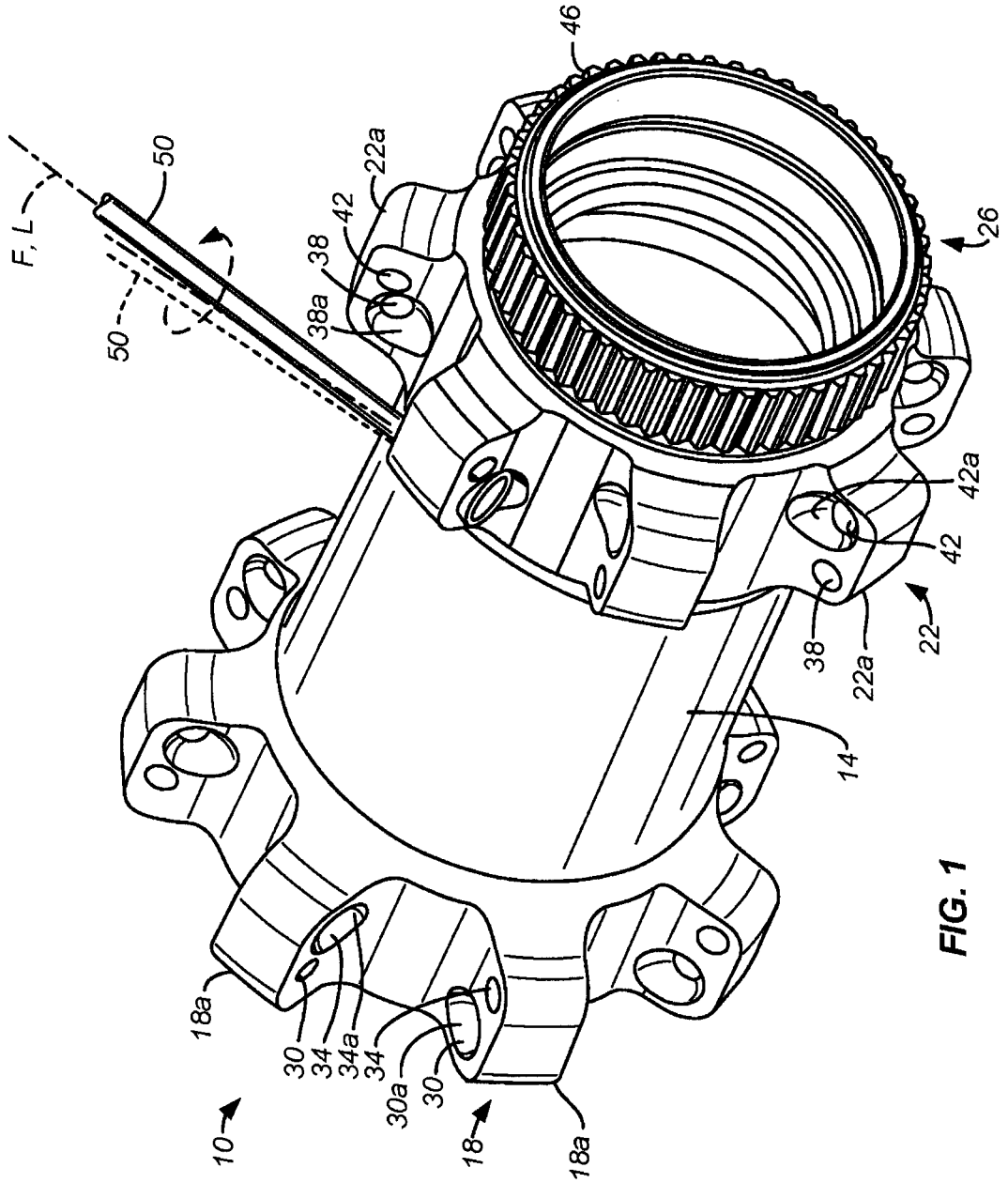
46
F, L
50
50
22a
42
38
38a
26
42a
42
22
38
22a
14
18a
30
34
34a
34
30a
30
10
18
18a

FIG. 1

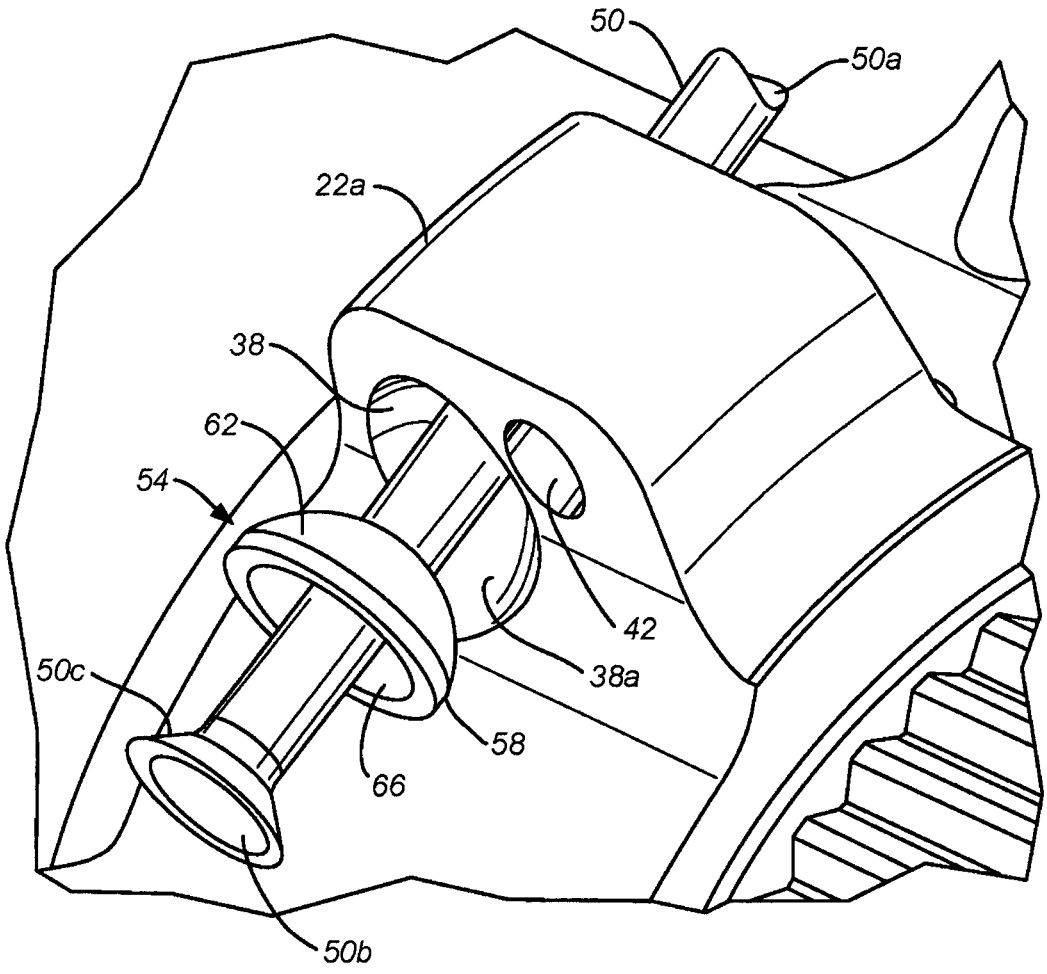

FIG. 2

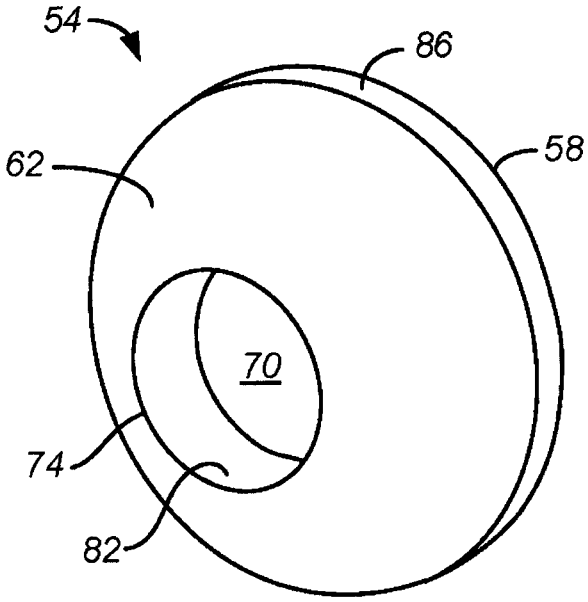

FIG. 3A

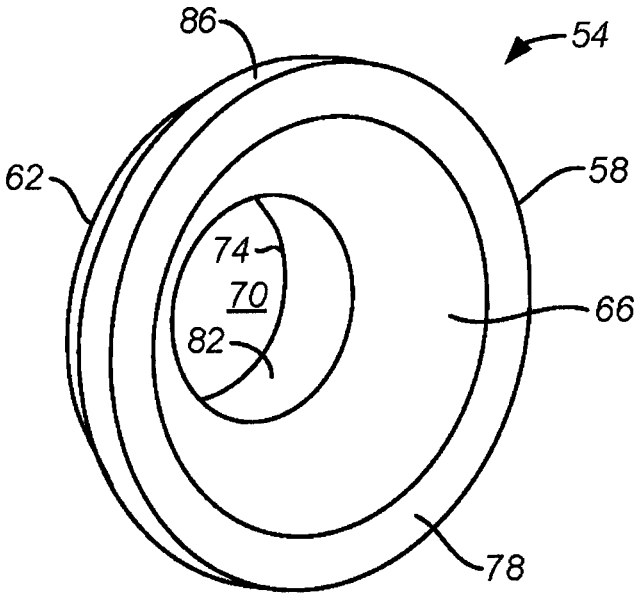

FIG. 3B

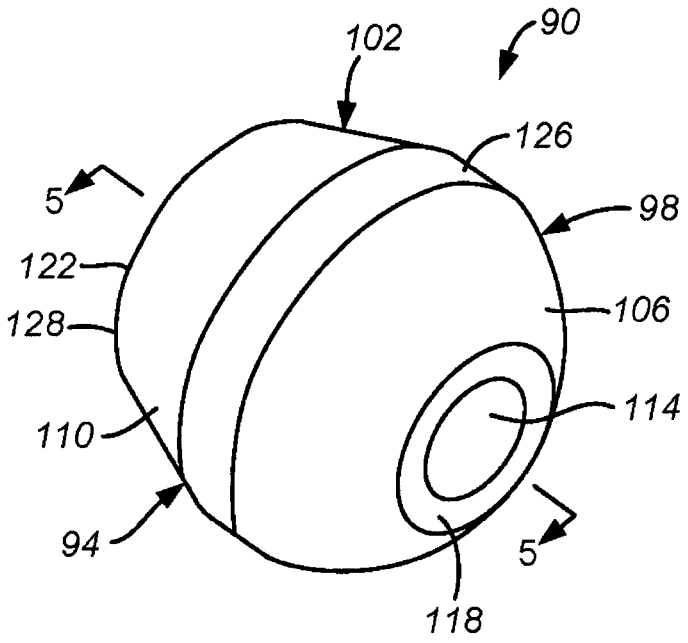
102
90
126
5
98
122
106
128
114
110
94
5
118

FIG. 4

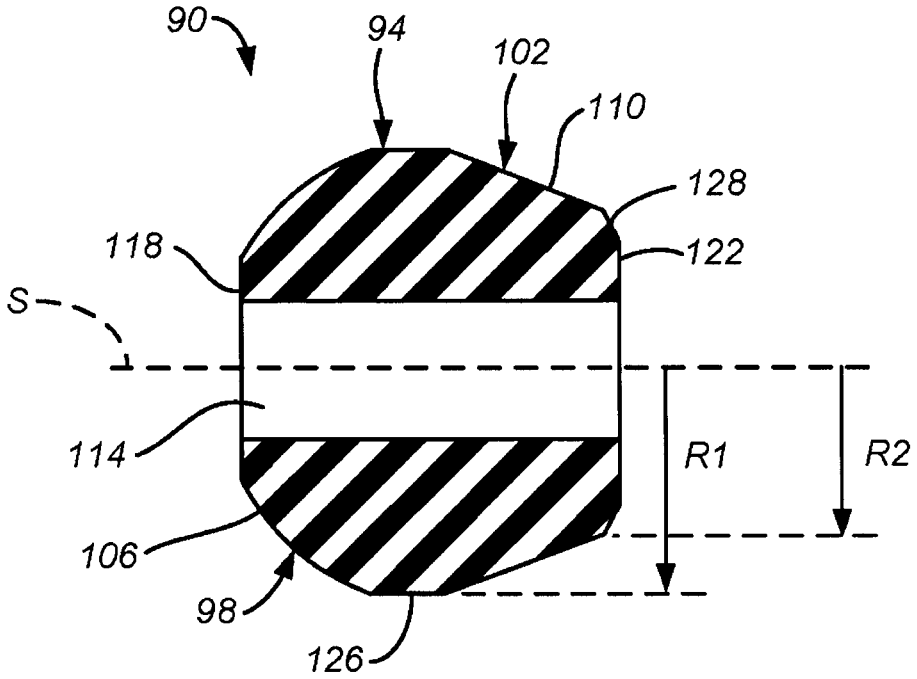
90
94
102
110
128
118
122
S
114
R1
R2
106
98
126

FIG. 5

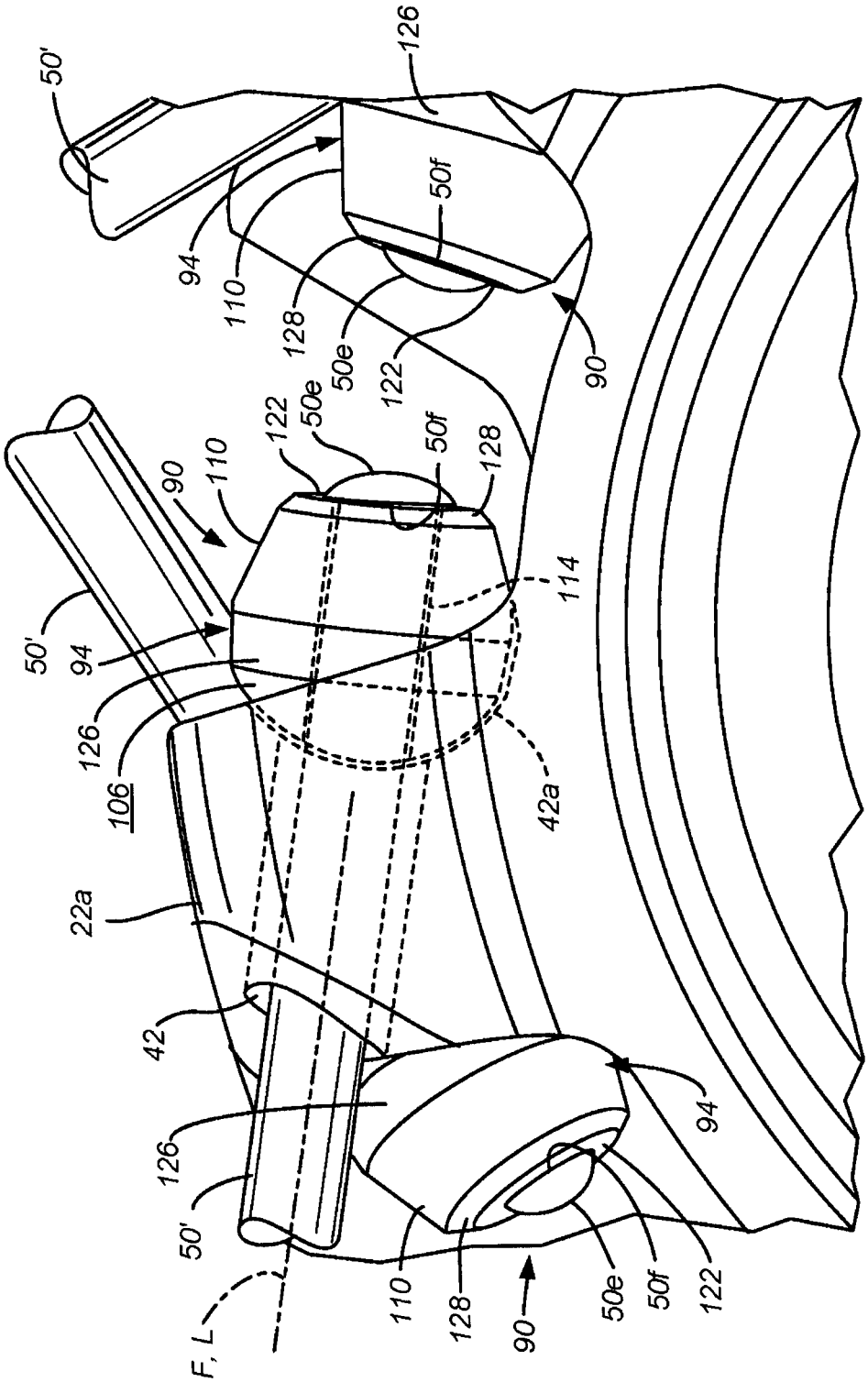

FIG. 6

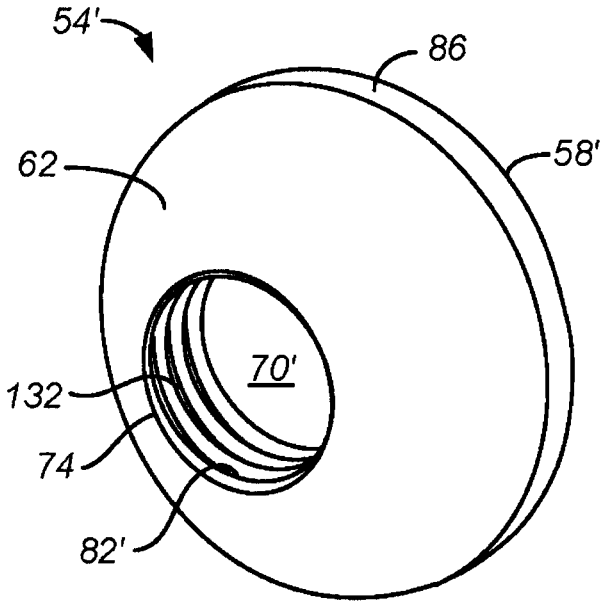

FIG. 7A

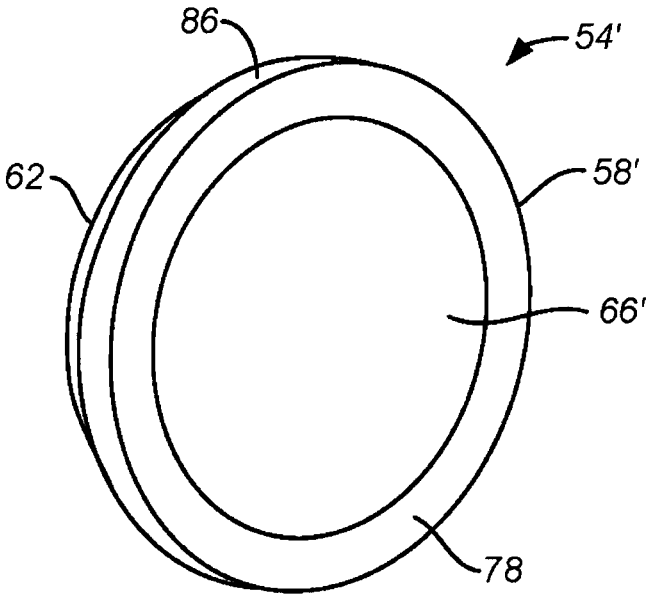

FIG. 7B

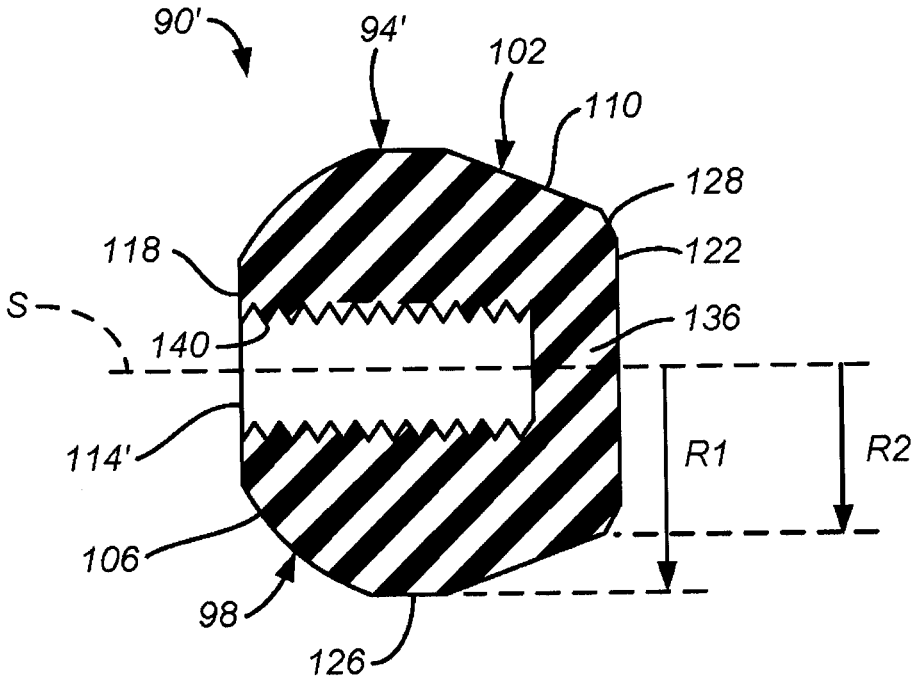

FIG. 8

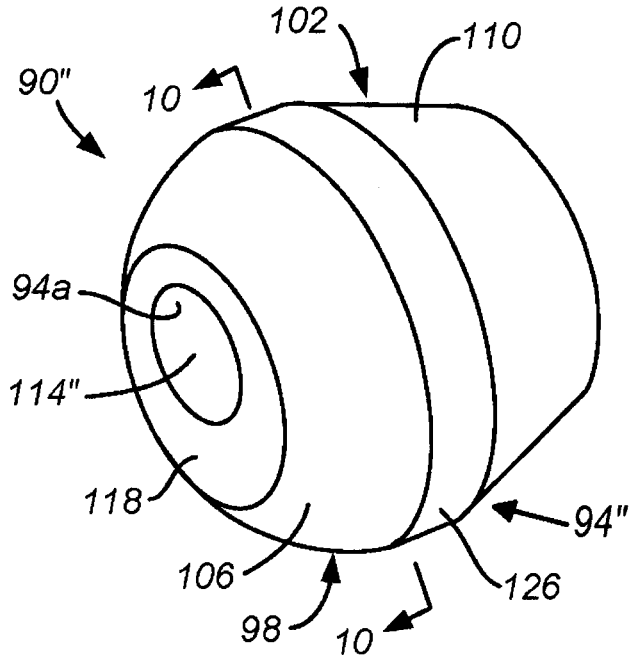
102
110
90"
10
94a
114"
118
94"
106
126
98
10

FIG. 9

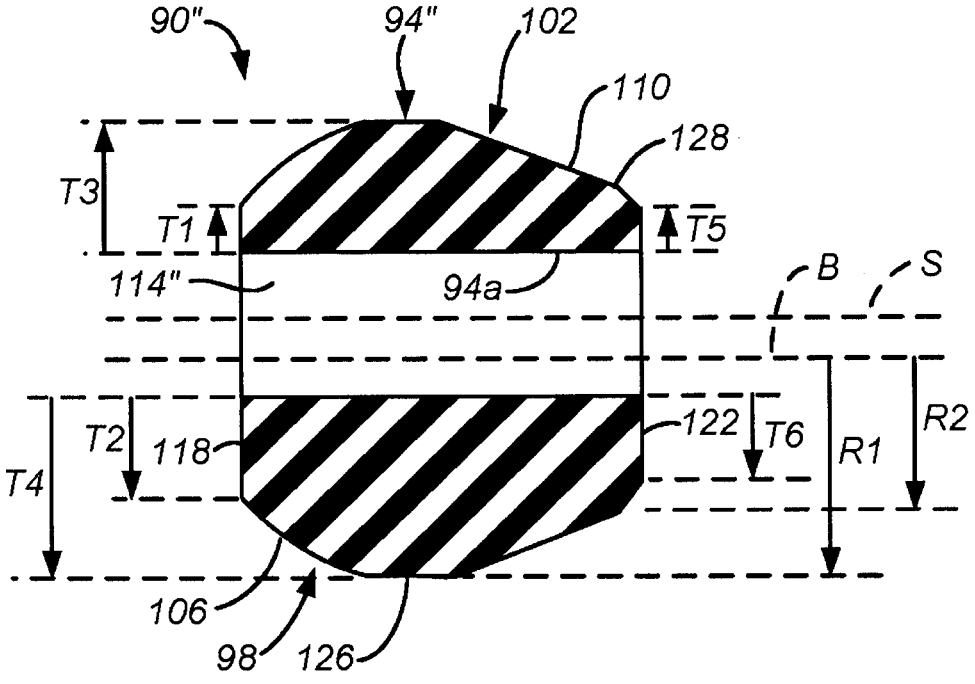
90"
94"
102
110
128
T3
T1
T5
114"
94a
B
S
T2
118
122
T6
R1
R2
T4
106
98
126

FIG. 10

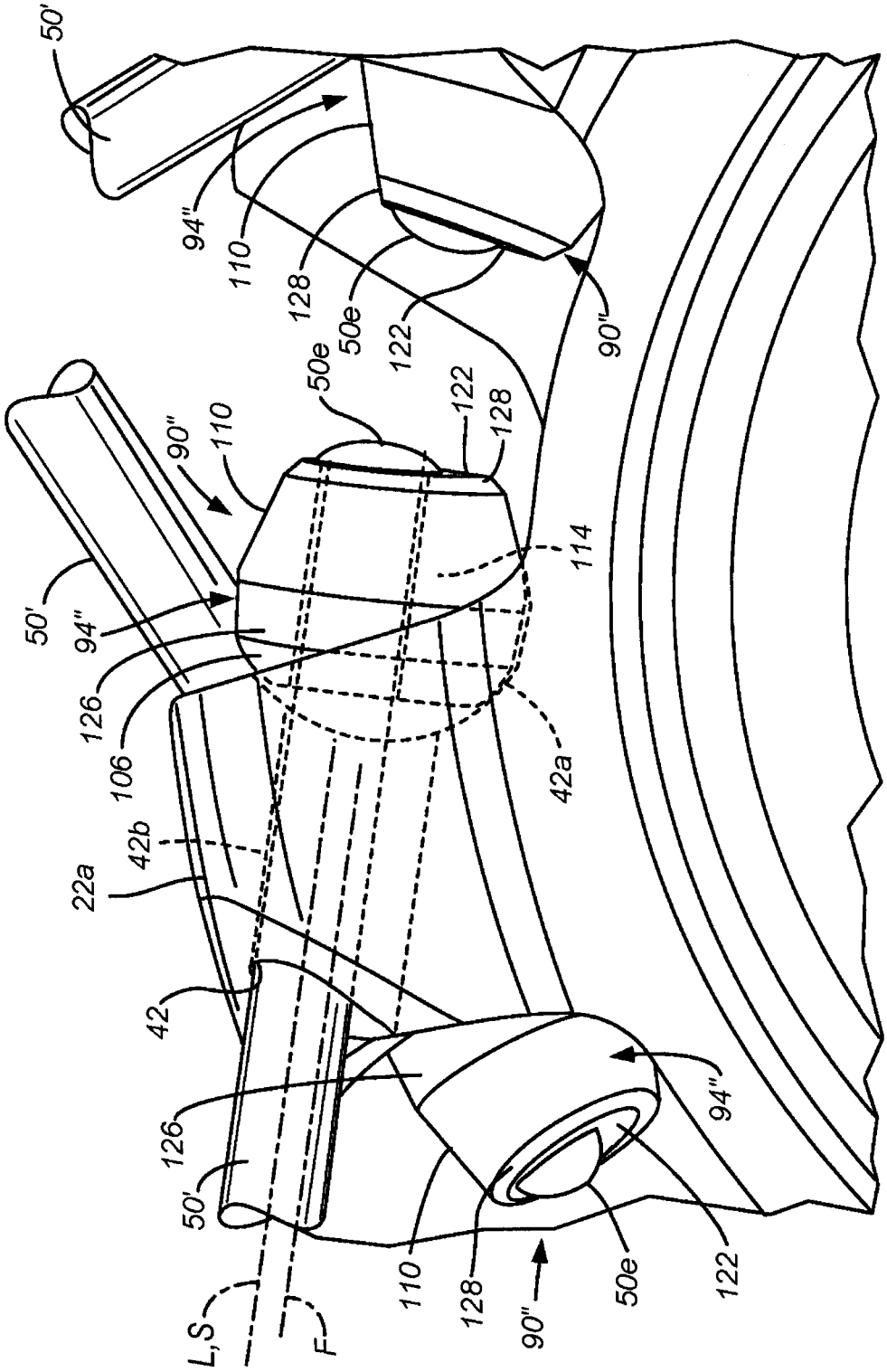
50'
94"
110
128
50e
122
90"
50e
122
128
90"
110
114
50'
94"
126
106
42a
42b
22a
42
126
50'
94"
110
128
90"
50e
122
L,S
F

FIG. 11

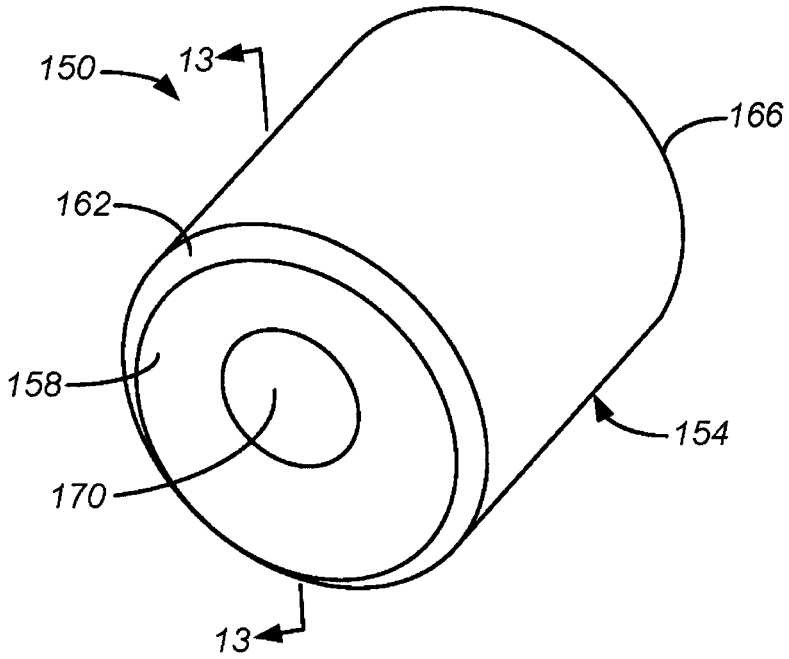
150
13
166
162
158
154
170
13

FIG. 12

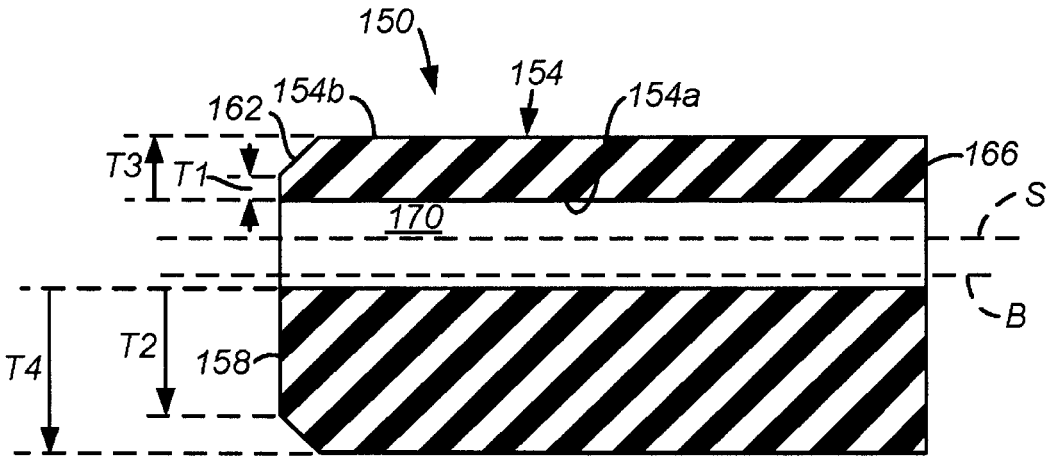
150
154
162
154b
154a
166
T3
T1
170
S
B
T4
T2
158

FIG. 13

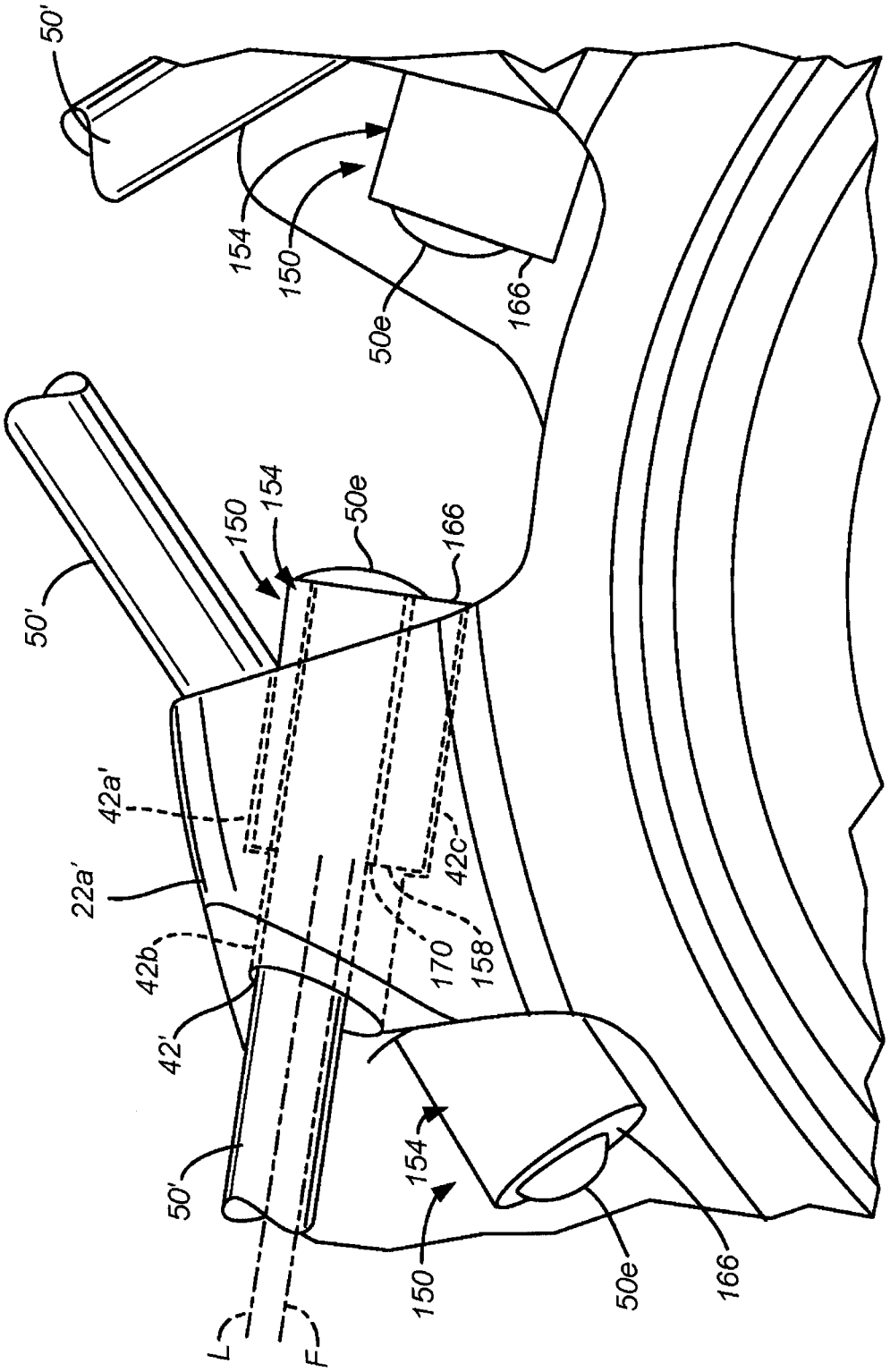
50'
154
150
50e
166
50'
150
154
50e
166
42a'
22a'
42b
42'
42c
170
158
50'
154
150
50e
166
L
F

FIG. 14

FORCE-DISTRIBUTING APPARATUS FOR A BICYCLE WHEEL SPOKE

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. patent application Ser. No. 13/369,489 filed Feb. 9, 2012 and titled "Force Distributing Apparatus for a Bicycle Wheel Spoke."

BACKGROUND OF THE INVENTION

The present invention is directed to bicycle wheels and, more particularly, to a force-distributing apparatus for a bicycle wheel spoke.

A typical bicycle wheel comprises a hub that is rotatably mounted around a hub shaft, an annular rim structured to support a tire, and a plurality of spokes that connect the hub to the rim. The hub typically includes a pair of spaced-apart hub flanges, wherein each hub flange includes a plurality of circumferentially-disposed openings. The wheel rim also includes a plurality of circumferentially-disposed openings. Each spoke typically has an enlarged head at one end and a threaded shaft at the other end. The spoke extends through a corresponding opening in one of the hub flanges and through a corresponding opening in the wheel rim until the head abuts against the hub flange. The spoke is fastened to the wheel rim by a threaded nut that is screwed onto the threaded shaft and abuts against the wheel rim.

SUMMARY OF THE INVENTION

The present invention is directed to various features of a force-distributing apparatus for a bicycle wheel spoke. In one embodiment, a force-distributing apparatus for a bicycle wheel spoke comprises a force-distributing body having a free-end first surface and a second surface disposed at an opposite side of the first surface. The force-distributing body has a spoke-receiving opening that extends through the first surface. In one embodiment, the first surface substantially has the shape of a truncated sphere. In another embodiment, the force distributing body has a generally cylindrical shape. In another embodiment, the spoke-receiving opening is formed eccentrically in the force-distributing body.

In another embodiment, a force-distributing apparatus is provided for a bicycle wheel spoke, wherein the spoke is structured to be mounted to a hub flange of the bicycle wheel, and wherein the hub flange includes an opening with a flange-opening axis. The apparatus comprises a force-distributing body including a free-end first surface, a second surface disposed at an opposite side of the first surface, and a spoke-receiving opening. The first surface of the force-distributing body is structured to engage the hub flange when the spoke is mounted to the hub flange, and at least one of the first surface or the second surface is shaped to allow the spoke to move in any lateral direction relative to the flange-opening axis.

Additional inventive features will become apparent from the description below, and such features alone or in combination with the above features and their equivalents may form the basis of further inventions as recited in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a particular embodiment of a bicycle wheel hub with a spoke and a force-distributing apparatus mounted to a hub flange in a rest position;

FIG. **2** is a more detailed perspective view showing the relationship of the hub flange, the spoke, and the force-distributing apparatus;

FIG. **3**A is a front perspective view of the force-distributing apparatus;

FIG. **3**B is a rear perspective view of the force-distributing apparatus;

FIG. **4** is a perspective view of another embodiment of a force-distributing apparatus;

FIG. **5** is a view taken along line **5-5** in FIG. **4**;

FIG. **6** is a side view showing a plurality of spokes mounted to a hub flange of the bicycle wheel hub using the alternative force-distributing apparatus shown in FIGS. **4** and **5**;

FIG. **7**A is a front perspective view of an alternative embodiment of a force-distributing apparatus;

FIG. **7**B is a rear perspective view of another alternative embodiment of a force-distributing apparatus;

FIG. **8** is a cross-sectional view, similar to FIG. **5**, of another alternative embodiment of a force-distributing apparatus;

FIG. **9** is a perspective view of another embodiment of a force-distributing apparatus;

FIG. **10** is a view taken along line **10-10** in FIG. **9**;

FIG. **11** is a side view showing a plurality of spokes mounted to a hub flange of the bicycle wheel hub using the alternative force-distributing apparatus shown in FIGS. **9** and **10**;

FIG. **12** is a perspective view of another embodiment of a force-distributing apparatus;

FIG. **13** is a view taken along line **13-13** in FIG. **12**; and

FIG. **14** is a side view showing a plurality of spokes mounted to a hub flange of the bicycle wheel hub using the alternative force-distributing apparatus shown in FIGS. **12** and **13**.

DETAILED DESCRIPTION OF THE EMBODIMENTS

FIG. **1** is a perspective view of a bicycle wheel hub **10** that comprises a hollow hub body **14**, a first hub flange unit **18**, a second hub flange unit **22**, and a brake rotor fixing unit **26**. First hub flange unit **18** includes a plurality of circumferentially-disposed and radially-extending hub flanges **18***a*, each of which has a first spoke-mounting opening **30** and a second spoke-mounting opening **34**. Each first spoke-mounting opening **30** includes a clockwise-facing contact surface **30***a*, and each second spoke-mounting opening **34** includes a counterclockwise-facing contact surface **34***a*. Similarly, second hub flange unit **22** includes a plurality of circumferentially-disposed and radially-extending hub flanges **22***a*, each of which has a first spoke-mounting opening **38** and a second spoke-mounting opening **42**. Each first spoke-mounting opening **38** includes a counterclockwise-facing contact surface **38***a*, and each second spoke-mounting opening **42** includes a clockwise-facing contact surface **42***a*. Brake rotor fixing unit **26** comprises a plurality of circumferentially-disposed splines **46** that are used to mount a conventional disk brake rotor.

FIG. **1** shows a spoke **50** mounted to hub flange **22** in a rest position. As shown in FIG. **2**, spoke **50** includes an elongated spoke body **50***a* and a spoke mounting element in the form of an enlarged spoke head **50***b* for mounting spoke **50** to hub flange **22**, wherein spoke body **50***a* extends through first opening **38** in hub flange **22***a*. In this embodiment, spoke head **50***b* includes a contact surface **50***c* in the form of a frustum of a hemisphere. A force-distributing

apparatus in the form of a force-distributing member **54** is disposed between contact surface **38***a* of hub flange **22***a* and contact surface **50***c* of spoke **50**.

As shown in FIGS. **3***a* and **3***b*, force-distributing member **54** includes a force-distributing body **58** that has the shape of a truncated sphere. As used herein, the phrase "shape of a truncated sphere" applies to "generally has the shape of a truncated sphere," such as generally the shape of a hemisphere, such as generally the shape of a frustum of a sphere, such as generally the shape of a frustum of a hemisphere, such as generally the shape of a frustum of a hollow hemisphere, and optionally a true frustum of a hollow hemisphere. The word "sphere," applied to a hollow or solid, convex or concave object, has the ordinary definition of a three-dimensional surface, all points of which are substantially equidistant from a fixed point. The word "truncated" in the context of a geometrical object has the ordinary meaning of having the apex cut off, preferably but not necessarily by a plane.

Force-distributing body **58** has a convex free-end first surface **62**, a concave second surface **66** disposed at an opposite side of first surface **62**, and a centrally-disposed spoke-receiving opening **70** that extends through first surface **62** and second surface **66**. A circular front edge **74** is formed at the junction of first surface **62** and spoke-receiving opening **70**, and an annular, planar rear edge **78** is formed at the rear of force-distributing body **58**. A cylindrical inner transition surface **82** is formed between front edge **74** and second surface **66**, and a cylindrical outer transition surface **86** is formed between first surface **62** and rear edge **78**. As a result of the foregoing structures, first surface **62** and second surface **66** each generally has the shape of a truncated sphere, such as generally the shape of a hemisphere, such as generally the shape of a frustum of a sphere, such as generally the shape of a frustum of a hemisphere, and optionally a true frustum of a hemisphere.

As shown in FIGS. **1** and **2**, first surface **62** of force-distributing member **54** is structured to engage contact surface **38***a* of first spoke-mounting opening **38** in hub flange **22***a*, and second surface **66** of force-distributing member **54** is structured to engage contact surface **50***c* of spoke head **50***b*. The same is true when spokes **50** are mounted in openings **30** and **34** in hub flanges **18***a* and in the other openings **38** and **42** in hub flanges **22***a*. The portion of each contact surface **30***a*, **34***a*, **38***a* and **42***a* that engages first surface **62** of a corresponding force-distributing member **54** generally has the shape of a truncated sphere, such as generally the shape of a hemisphere, such as generally the shape of a frustum of a sphere, such as generally the shape of a frustum of a hemisphere, and optionally a true frustum of a hemisphere.

When spoke **50** is mounted to hub flange **22***a* in the rest position shown in FIG. **1**, spoke **50** defines a longitudinal rest-position axis L that aligns with a flange-opening axis F. Contact surface **38***a* of first spoke-mounting opening **38** and first surface **62** of force-distributing member **54** form a ball joint when spoke **50** is mounted to hub flange **22***a*. As a result, spoke **50** can be mounted at any angle relative to hub flange **22***a*. Furthermore, spoke **50** can gyrate or otherwise move in any direction relative to axes F and L as shown by broken lines in FIG. **1**. In this embodiment, contact surface **50***c* of spoke head **50***a* and second surface **66** of force-distributing member **54** also form a ball joint when spoke **50** is mounted to hub flange **22***a* so that spoke **50** can gyrate or otherwise move in any direction relative to axes F and L. The same is true when spokes **50** are mounted in openings **30** and **34** in hub flanges **18***a* and in the other openings **38** and **42** in hub flanges **22***a*. As a result, hub flanges **18***a* and **22***a* can accommodate any motion of spokes **50** caused by lateral forces applied to the wheel rim, thereby avoiding undesirable stresses to spokes **50** during operation of the bicycle.

FIG. **4** is a perspective view of another embodiment of a force-distributing apparatus in the form of a force-distributing member **90**, and FIG. **5** is a cross-sectional view taken along line **5-5** in FIG. **4**. In this embodiment, force-distributing member **90** comprises a force-distributing body **94** including a first portion **98** and a second portion **102**. A convex first surface **106** is disposed on first portion **98**, a second surface **110** is disposed on second portion **102**, and a spoke-receiving opening **114** extends through first portion **98** and second portion **102** to form a spoke-receiving axis S (FIG. **5**). An annular, planar front edge **118** is formed at the front of force-distributing body **94**, and an annular, planar rear edge **122** is formed at the rear of force-distributing body **94**. A generally cylindrical outer transition surface **126** is formed between first surface **106** and second surface **110**, and an annular beveled surface **128** is formed between second surface **110** and rear edge **122**. Second surface **110** is tapered relative to spoke-receiving axis S so that a radius R**1** of second surface **110** at outer transition surface **126** is greater than a radius R**2** of second surface **110** at beveled surface **128**. In this embodiment, first surface **106** generally has the shape of a truncated sphere, such as generally the shape of a hemisphere, such as generally the shape of a frustum of a sphere, such as generally the shape of a frustum of a hemisphere, and optionally a true frustum of a hemisphere. Second surface **110** generally has a conical shape, such as generally the shape of a truncated cone, such as generally the shape of a frustum of a cone, and optionally a true frustum of a cone.

FIG. **6** is a side view showing a plurality of modified spokes **50'** mounted to hub flange **22***a*, for example, using force-distributing member **90**. Each spoke **50'** has a modified spoke head **50***e* in the form of a hemisphere with a flat annular surface **50***f* that contacts rear edge **122** of a corresponding force-distributing member **90** when spoke **50'** is mounted to flange **22***a*.

Hub flanges **18***a* and **22***a* have the same structure as in the first embodiment. Thus, as shown in FIG. **6**, as in the first embodiment, first surface **106** of each force-distributing member **90** is structured to engage a corresponding contact surface (e.g., contact surface **42***a*) of a spoke-mounting opening (e.g., second spoke-mounting opening **42**). First surface **106** of force-distributing member **90** and contact surface **42***a* of second spoke-mounting opening **42** form a ball joint when spoke **50'** is mounted to hub flange **22***a*. As a result, as in the first embodiment, spoke **50'** can be mounted at any angle relative to hub flange **22***a*, and spoke **50'** can gyrate or otherwise move in any direction relative to axes F and L in response to lateral forces applied to the bicycle wheel.

While the above is a description of various embodiments of inventive features, further modifications may be employed without departing from the spirit and scope of the present invention. For example, while inner transition surface **82** in the first embodiment was smooth, FIG. **7**A shows an embodiment wherein an inner transition surface **82'** a force-distributing body **58'** of a force-distributing member **54'** forms, at least in part, a threaded inner peripheral surface **132** to form a threaded opening **70'** so that a threaded end of a spoke can be screwed directly into force-distributing body **58'**. If desired, as shown in FIG. **7**B, a modified second surface **66'** may partially or completely close off the rear of

spoke-receiving opening **70**. FIG. **7**B shows second surface **66'** completely closing off the rear of spoke receiving opening **70** so that spoke receiving opening **70** is a blind opening, preferably with the threaded inner transition surface **82'** shown in FIG. **7**A.

While spoke-receiving opening **114** in the second embodiment extended through both front edge **118** and rear edge **122** of force-distributing body **94** as shown in FIG. **5**, FIG. **8** shows an embodiment of a force-distributing body **94'** wherein a rear wall **136** partially or completely closes off the rear of a spoke-receiving opening **114'**. FIG. **8** shows rear wall **136** completely closing off the rear of spoke-receiving opening **114'** so that spoke-receiving opening **114'** is a blind opening. A threaded inner peripheral surface **140** is formed, at least in part, around spoke-receiving opening **114'** so that a threaded end of a spoke can be screwed directly into force-distributing body **94'**.

While the spoke-receiving opening in each of the above embodiments was formed concentrically in the force-distributing member, additional benefits can be obtained by forming the spoke-receiving opening eccentrically in the force-distributing member. For example, FIGS. **9-10** illustrate another embodiment of a force-distributing member **90"** similar to force-distributing member **90** in FIGS. **4-5**. The parts of force-distributing member **90"** that are the same as force distributing member **90** are numbered the same. In this embodiment, a spoke-receiving opening **114"** is formed eccentrically within a force-distributing body **94"** of force-distributing member **90"**.

More specifically, as shown in FIG. **10**, an unthreaded spoke receiving opening **114"** is formed by an inner peripheral surface **94***a* of force-distributing body **94"** and defines a spoke-receiving-axis S that is offset from but parallel to a force-distributing-body axis B that is concentric with force-distributing body **94"**. As a result, a thickness T**1** of the upper portion of force-distributing body **94"** at front edge **118** is less than a thickness T**2** of the lower portion of force-distributing body **94"** at front edge **118**, a thickness T**3** of the upper portion of force-distributing body **94"** at outer transition surface **126** is less than a thickness T**4** of the lower portion of force-distributing body **94"** at outer transition surface **126**, and a thickness T**5** of the upper portion of force-distributing body **94"** at rear edge **122** is less than a thickness T**6** of the lower portion of force-distributing body **94"** at rear edge **122**. Second surface **110** is tapered relative to force-distributing-body axis B so that a radius R**1** of second surface **110** at outer transition surface **126** is greater than a radius R**2** of second surface **110** at beveled surface **128**. Thus, when force-distributing member **90"** is mounted to a hub flange **22***a* with a spoke **50'** as shown in FIG. **11**, spoke **50'** abuts against an inner peripheral surface **42***b* of a spoke-mounting flange **22**, and rest-position axis L of spoke **50'** is offset from flange-opening axis F. As a result, the lower portion of force-distributing body **94"** presses against contact surface **42***a* of spoke-mounting opening **42**, thereby creating a frictional force that inhibits force-distributing member **90"** from rotating relative to contract surface **42***a* and preventing spoke **50'** from unscrewing from the nut at the wheel rim.

FIGS. **12-13** illustrate another embodiment of a force-distributing member **150**. Force distributing member **150** comprises a generally cylindrically-shaped force-distributing body **154**, an annular, planar front edge **158** with a beveled edge **162**, an annular, planar rear edge **166**, and an unthreaded spoke-receiving opening **170** that is formed eccentrically within force-distributing body **154**.

As shown in FIG. **13**, spoke receiving opening **170** is formed by an inner peripheral surface **154***a* of force-distributing body **154** and defines a spoke-receiving-axis S that is offset from but parallel to a force-distributing-body axis B that is concentric with force-distributing body **154**. As a result, a thickness T**1** of the upper portion of force-distributing body **154** at front edge **158** is less than a thickness T**2** of the lower portion of force-distributing body **154** at front edge **158**, and a thickness T**3** of the upper portion of force-distributing body **154** at an outer peripheral surface **154***b* of force-distributing body **154** is less than a thickness T**4** of the lower portion of force-distributing body **154** at outer peripheral surface **154***b*. Thus, as shown in FIG. **14**, when force-distributing member **150** is mounted with a spoke **50'** within a cylindrically-shaped bore **42***a'* of a modified spoke mounting opening **42'** of a modified hub flange **22***a'*, spoke **50'** abuts against an inner peripheral surface **42***b* of spoke-mounting flange **22***a'*, and rest-position axis L of spoke **50'** is offset from flange-opening axis F. As a result, the lower portion of force-distributing body **154** presses against an inner peripheral surface **42***c* of cylindrically-shaped bore **42***a'*, thereby creating a frictional force that prevents force-distributing member **154** from rotating relative to inner peripheral surface **42***c* and preventing spoke **50'** from unscrewing from the nut at the wheel rim.

The size, shape, location or orientation of the various components may be changed as desired. Components that are shown directly connected or contacting each other may have intermediate structures disposed between them. Separate components may be combined, and vice versa. The functions of one element may be performed by two, and vice versa. The function of one element may be performed by another, and functions may be interchanged among the elements. The structures and functions of one embodiment may be adopted in another embodiment. It is not necessary for all advantages to be present in a particular embodiment at the same time. Every feature which is unique from the prior art, alone or in combination with other features, also should be considered a separate description of further inventions by the applicant, including the structural and/or functional concepts embodied by such feature(s). Terms of degree such as "substantially," "about" and "approximately" as used herein include a reasonable amount of deviation of the modified term such that the end result is not significantly changed. Thus, the scope of the invention should not be limited by the specific structures disclosed or the apparent initial focus or emphasis on a particular structure or feature.

What is claimed is:

1. A force distributing apparatus for a bicycle wheel spoke mounting element for a spoke having an elongated spoke body, wherein the spoke mounting element is enlarged relative to the spoke body for mounting the spoke to a hub flange of a bicycle wheel hub, wherein the apparatus comprises:

a force-distributing body having a free-end first surface and a second surface disposed at an opposite side of the first surface;

wherein the first surface has the shape of a truncated sphere;

wherein the entire second surface that contacts the spoke mounting element has the shape of a frustum of a sphere; and

wherein the force-distributing body has a spoke-receiving opening that extends through the first surface.

2. The apparatus according to claim **1** wherein the force-distributing body has the shape of a truncated sphere.

3. The apparatus according to claim **2** wherein the first surface has the shape of a frustum of a sphere.

4. The apparatus according to claim **2** wherein the force-distributing body has the shape of a frustum of a sphere.

5. The apparatus according to claim **2** wherein the second surface has a concave shape.

6. A force distributing apparatus for a bicycle wheel spoke mounting element for a spoke having an elongated spoke body, wherein the spoke mounting element is enlarged relative to the spoke body for mounting the spoke to a hub flange of a bicycle wheel hub, wherein the hub flange includes an opening with a flange-opening axis, and wherein the apparatus comprises:

a force-distributing body including:

a free-end first surface;

a second surface disposed at an opposite side of the first surface; and

a spoke-receiving opening;

wherein the first surface is structured to engage the hub flange when the spoke mounting element is mounted to the hub flange;

wherein the second surface is shaped to allow the spoke mounting element to move in any lateral direction relative to the force distributing body; and

wherein at least one of the first surface or the second surface is shaped to allow the spoke mounting element to move in any lateral direction relative to the flange-opening axis.

7. The apparatus according to claim **6** wherein the first surface is shaped to allow the spoke mounting element to move in any lateral direction relative to the flange-opening axis when the spoke mounting element is mounted to the hub flange.

8. The apparatus according to claim **6** wherein the second surface is shaped to allow the spoke mounting element to move in any lateral direction relative to the flange-opening axis when the spoke mounting element is mounted to the hub flange.

9. The apparatus according to claim **6** wherein the first surface has the shape of a truncated sphere.

10. The apparatus according to claim **9** wherein the force-distributing body has the shape of a frustum of a sphere.

11. The apparatus according to claim **9** wherein the second surface has a concave shape.

12. The apparatus according to claim **11** wherein the second surface has the shape of a frustum of a sphere.

13. The apparatus according to claim **9** wherein the first surface has the shape of a frustum of a sphere.

14. The apparatus according to claim **6** wherein the entire second surface that contacts the spoke mounting element has the shape of a frustum of a sphere.

15. The apparatus according to claim **6** wherein the second surface has a concave shape, and wherein the entire second surface has the shape of a frustum of a sphere.

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